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(54) VEHICLE AIR CONDITIONER HAVING A SEAT AIR CONDITIONING UNIT

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(57) **ABSTRACT**

In a vehicle air conditioner, a front air conditioning unit and a seat air conditioning unit are automatically controlled by an air conditioner ECU. If a seat air conditioner switch is operated by a user during an automatic control, the setting (e.g. air volume of a seat blower) of the seat air conditioning switch is learned. Based on the learning, a seat blower characteristic diagram, which is stored in a ROM, is changed. Therefore, from this time onward, under the same environmental condition, the seat blower air volume is determined based on the changed seat blower characteristic diagram. Accordingly, a seat air conditioning is provided as desired.

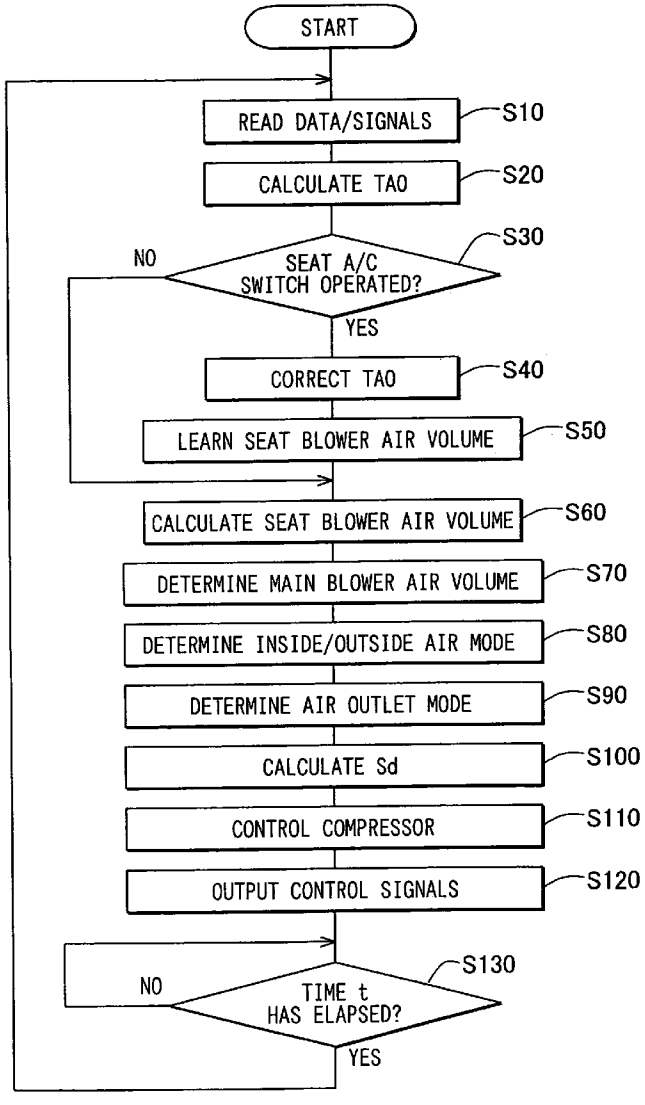


FIG. 1

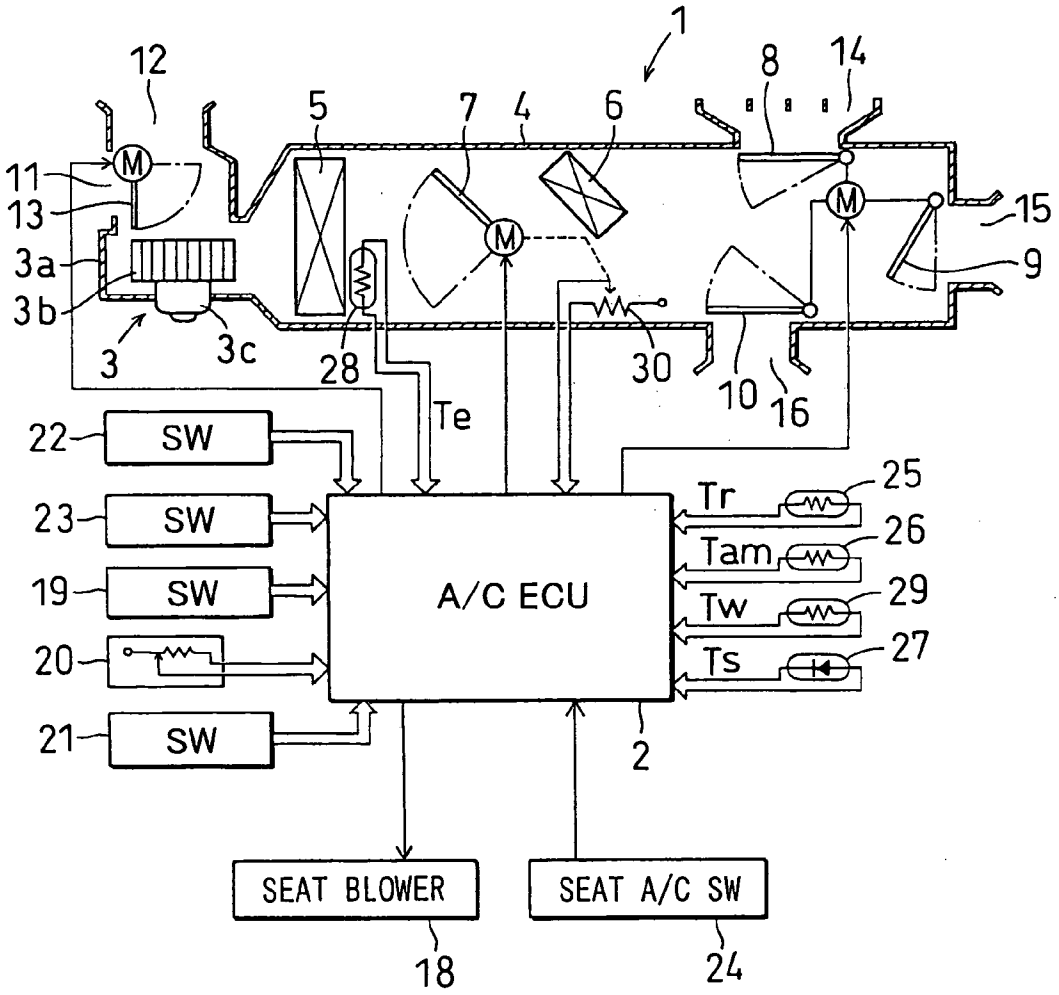

1
12
5
7
4
6
8
14
11
13
3a
3b
3
3c
28
30
10
16
15
9
Te
22
SW
23
SW
19
SW
20
21
SW
A/C ECU
Tr
25
Tam
26
Tw
29
Ts
27
2
SEAT BLOWER
18
SEAT A/C SW
24

FIG. 2

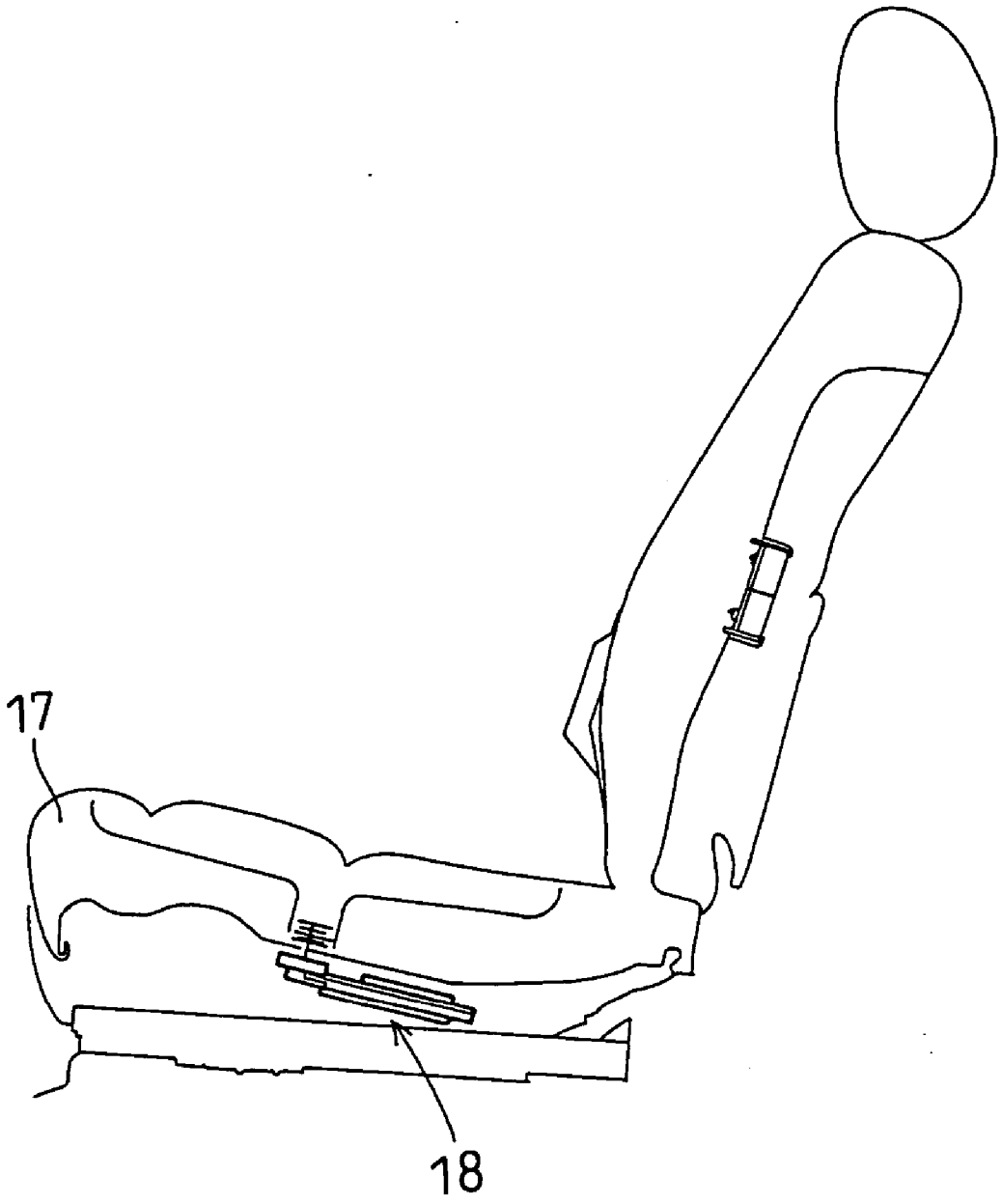


FIG. 3

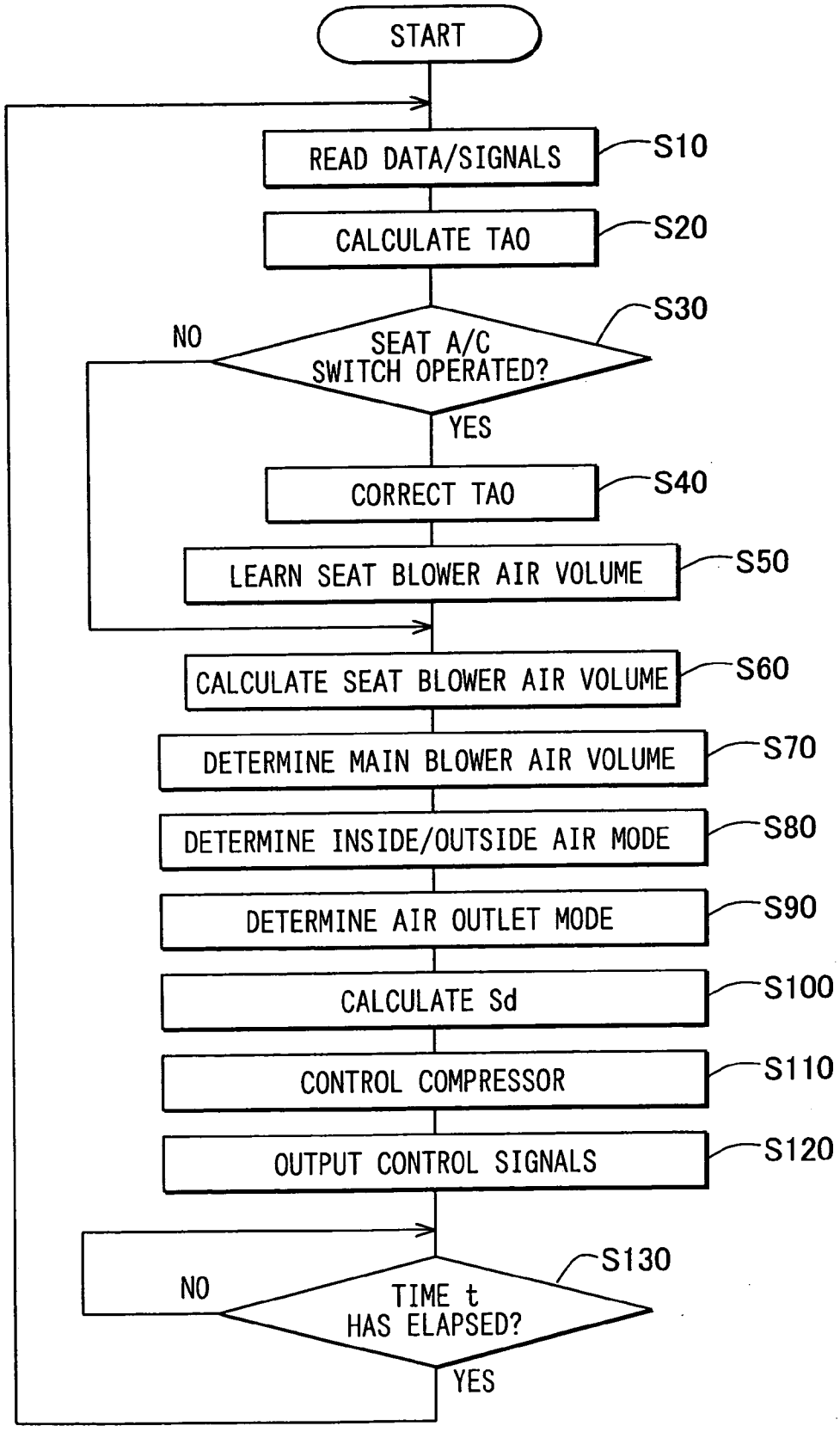

START
READ DATA/SIGNALS
S10
CALCULATE TAO
S20
SEAT A/C SWITCH OPERATED?
S30
NO
YES
CORRECT TAO
S40
LEARN SEAT BLOWER AIR VOLUME
S50
CALCULATE SEAT BLOWER AIR VOLUME
S60
DETERMINE MAIN BLOWER AIR VOLUME
S70
DETERMINE INSIDE/OUTSIDE AIR MODE
S80
DETERMINE AIR OUTLET MODE
S90
CALCULATE Sd
S100
CONTROL COMPRESSOR
S110
OUTPUT CONTROL SIGNALS
S120
TIME t HAS ELAPSED?
S130
NO
YES

FIG. 4

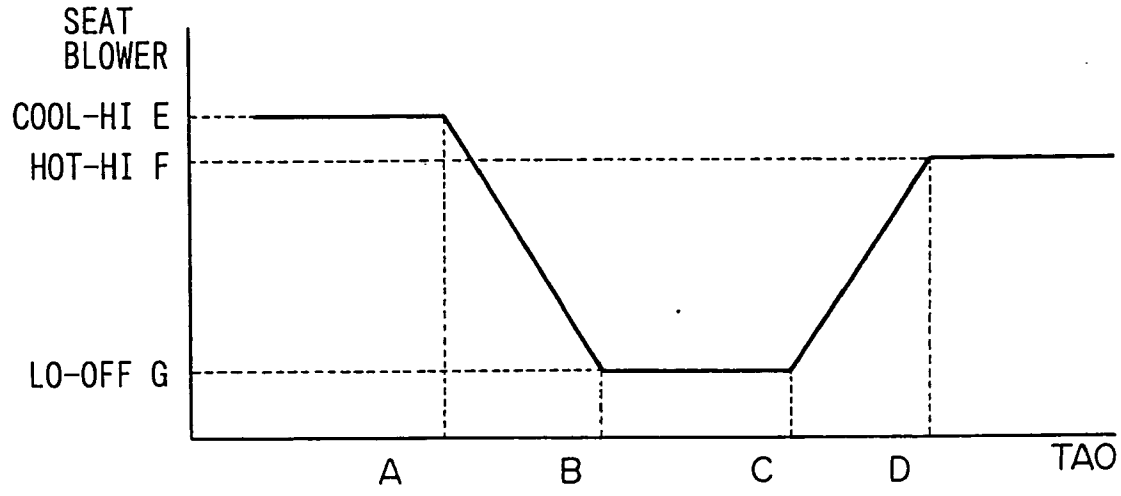
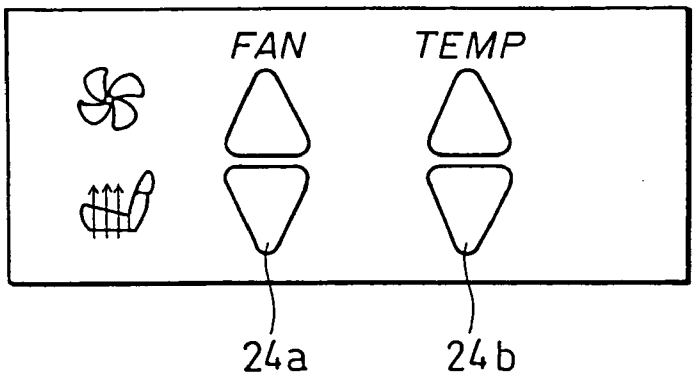


FIG. 5



VEHICLE AIR CONDITIONER HAVING A SEAT AIR CONDITIONING UNIT

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Application No. 2002-315481 filed on Oct. 30, 2002, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a vehicle air conditioner having a seat air conditioning unit for producing flow of air from a seat and a method of controlling the same.

BACKGROUND OF THE INVENTION

[0003] With regard to an automatic control of a general vehicle air conditioner, a target temperature of air to be blown into a passenger compartment is calculated in relation to a setting temperature, and the control is executed based on a control characteristic with respect to the target temperature as a parameter. The control characteristic is determined to be accepted by the majority of users. Therefore, the control condition of the automatic control may not be accepted by some users who have different heat sensations, for example.

[0004] To address this matter, in Japanese Patent JP-B2-3146573 and JP-B2-3111566 for example, when the control condition is changed by user's manual switch operation during the automatic control, the changed control condition is learned. Further, it is reflected to the control characteristic of the automatic control, thereby providing a desired air conditioning.

[0005] Incidentally, with regard to the air conditioner including a seat air conditioning unit that produces warm air or cold air blowing from a seat for further improving passenger comfort, the passenger's heat sensation and comfort are likely to be governed depending on the presence or absence of the air blowing from the seat, that is, on/off condition of the seat air conditioning unit.

SUMMARY OF THE INVENTION

[0006] The present invention is made in view of the foregoing matter and it is an object of the present invention to provide a vehicle air conditioner capable of performing an air-conditioning operation as desired even when a seat air-conditioning operation is performed.

[0007] According to the present invention, an air conditioner for a vehicle includes a seat air conditioner means that produces an airflow blowing from a seat of the vehicle. A control characteristic of the seat air conditioner means is stored in a storage means. The seat air conditioner means is automatically controlled by a control means based on the control characteristic. When a manual setting means is operated to change a control condition by a user while the seat air conditioner means is automatically controlled, a setting condition of the manual setting means is learned and the control characteristic stored in the storage means is changed based on the learning.

[0008] Accordingly, when the control condition of the seat air conditioner means is changed by the operation of the manual setting means, the changed control condition is learned, and the learning is reflected to the control characteristic stored in the storage means. Therefore, it is possible to provide the seat air conditioning operation as desired by the user.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings, in which like parts are designated by like reference numbers and in which:

[0010] **FIG. 1** is a schematic diagram of a vehicle air conditioner according to an embodiment of the present invention;

[0011] **FIG. 2** is a schematic cross-sectional view of a seat air conditioning unit according to the embodiment of the present invention;

[0012] **FIG. 3** is a flow chart for showing a control procedure of an air conditioner ECU according to the embodiment of the present invention;

[0013] **FIG. 4** is a graph for showing a characteristic of a blower of the seat air conditioning unit according to the embodiment of the present invention; and

[0014] **FIG. 5** is a plan view of a switch of the seat air conditioning unit according to a modified embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENT

[0015] An embodiment of the present invention will be described hereinafter with reference to the drawings.

[0016] Referring to **FIG. 1**, the vehicle air conditioner includes a front air conditioning unit **1** for air-conditioning a passenger compartment, a seat air conditioning unit for air-conditioning a seat, and an air conditioner ECU **2** for controlling a condition of air in the passenger compartment.

[0017] First, the front air conditioning unit **1** is constructed of a blower (main blower) **3**, a duct **4**, an evaporator **5**, a heater core **6**, an air mixing door **7**, air blow mode switching doors **8** through **10**, and the like. The blower **3** creates a flow of air. The duct **4** defines an air passage through which the air blown by the blower **3** is introduced into the passenger compartment. The evaporator **5** is disposed in the duct **4**. The heater core **6** is disposed downstream from the evaporator **5** in the duct **4**. The air mixing door **7** controls a temperature of air. The air blow mode switching doors **8** through **10** switch air blow modes.

[0018] The blower **3** includes a casing **3***a*, a centrifugal fan **3***b*, a blower motor **3***c*. The casing **3***a* is integrated with an inside and outside air switching box. The centrifugal fan **3***b* is arranged in the casing **3***a*. The fan **3***b* is driven by the blower motor **3***c*. The inside and outside air switching box is formed with an inside air port **11** through which an inside air inside the passenger compartment is introduced in the box and an outside air port **12** through which an outside air outside the passenger compartment is introduced in the box. The inside air port **11** and the outside air port **12** are opened and closed by an inside and outside air switching door **13**.

[0019] The duct **4** includes a cooler case for housing the evaporator **5** and a heater case for housing the heater core **6**. The cooler case is for example integrally formed with the

heater case. The heater case is formed with a defroster opening **14** through which the air is blown toward a windshield of the vehicle, a face opening **15** through which the air is blown toward the upper half of the passenger body, and a foot opening **16** through which the air is blown toward the lower half of the passenger body. As the above-mentioned air blow mode switching doors, a defroster door **8**, a face door **9**, and a foot door **10** are disposed for opening and closing the defroster opening **14**, the face opening **15**, and the foot opening **16**, respectively.

[**0020**] The evaporator **5** is generally included in a refrigerant cycle. A refrigerant of the refrigerant cycle flows inside of the evaporator **5**. The refrigerant, which has a low temperature, evaporates by absorbing latent heat of evaporation from the air, thereby cooling the air. That is, the evaporator **5** is a cooling heat exchanger for cooling an outside fluid. On the other hand, the heater core **6** is a heating heat exchanger. The heater core **6** performs heat exchange between the air passing outside of the heater core **6** and an engine coolant flowing inside of the heater core **6**. The air mixing door **7** controls the volume of the air passing through the heater core **6** and the volume of air bypassing the heater core **6**, and thereby adjusts a temperature of the air to be blown into the passenger compartment.

[**0021**] Next, as shown in **FIG. 2**, the seat air conditioning unit includes a seat blower **18** installed in a seat **17**. When the seat blower **18** is driven, the air is sucked from the passenger compartment into the seat air conditioning unit and blown into the passenger compartment through openings formed on the seat surface. For example, the seat air conditioning unit can be connected to the front air conditioning unit **1** through a duct (not shown), so that the seat air conditioner unit receives air from the front air conditioner unit **1** and blows it from the seat surface.

[**0022**] The air conditioner ECU **2** is an electronic control unit having a microcomputer. When an ignition key of the vehicle is turned on, the ECU **2** starts a program by receiving power from a battery of the vehicle.

[**0023**] The ECU **2** reads operation signals of switches **19** through **23** operated on an air conditioner operating panel (not shown) and a seat air conditioner switch **24** and other sensor signals or sensor information detected by various sensors (described later). Based on the signals, the ECU **2** performs the air conditioning control, such as a temperature control of the air to be blown, an air intake mode control, an air outlet mode control, an air volume control of the main blower **3**, an on/off control of a compressor, and an air volume control of the seat blower **18**.

[**0024**] On the air conditioner operating panel, an automatic control switch **19**, a temperature setting switch **20**, an air volume setting switch **21**, an intake port switching switch **22**, outlet port switching switch **23** and the like are provided. An execution of the air conditioning control is ordered to the ECU **20** by the auto-control switch **19**. A temperature of the passenger compartment (setting temperature Tset) is set by the temperature setting switch **20** on a level desired by the passenger. An air volume level of the blower **3** is changed stepwise or continuously by the air volume setting switch **21**. An outside air mode for sucking the outside air and an inside air mode for circulating the inside air are switched by the intake port switching switch **22**. Air outlet modes are selected by the outlet port switching switch **23**. The seat air conditioner switch **24** includes a seat blower air volume switch that adjusts the level of the air volume, which is blown from the seat **17**, stepwise or continuously.

[**0025**] As shown in **FIG. 1**, an inside air temperature sensor **25**, an outside air temperature sensor **26**, a solar radiation sensor **27**, an evaporator downstream sensor **28**, a coolant temperature sensor **29**, a potentiometer **30** are included as the sensors. The inside air temperature sensor **25** detects a temperature (inside air temperature Tr)inside of the passenger compartment. The outside air temperature sensor **26** detects a temperature (outside air temperature Tam) outside of the passenger compartment. The solar radiation sensor **27** detects the amount Ts of solar radiation. The evaporator downstream sensor **28** detects a temperature (evaporator downstream temperature Te) of the air cooled by the evaporator **5**. The coolant temperature sensor **29** detects a temperature (coolant temperature Tw) of the engine coolant. The potentiometer **30** detects an opening degree of the air mixing door **7**.

[**0026**] Next, a control procedure of the air conditioner ECU **2** will be described with reference to the flow chart shown in **FIG. 3**. The ECU executes the air-conditioning control when the automatic control switch **19** is turned on.

[**0027**] At step **10**, the setting temperature Tset and the data or sensor information detected by the sensors, such as the inside air temperature Tr, the outside air temperature Tam, the solar radiation amount Ts, the evaporator downstream temperature Te, the coolant temperature Tw, are read.

[**0028**] Next, at step **20**, a target temperature TAO of the air to be blown into the passenger compartment is calculated based on a following equation 1. The equation 1 is stored in a ROM of the microcomputer, which provides a storage means.

$$TAO=Kset\times Tset-Kr\times Tr-Kam\times Tam-Ks\times Ts+C \quad \text{(Ex. 1)}$$

[**0029**] Here, Kset denotes a temperature setting gain. Kr denotes an inside air temperature gain. Kam denotes an outside air temperature gain. Ks denotes a solar radiation gain. C denotes a correction gain.

[**0030**] Next, at step **30**, it is determined whether the seat air conditioner switch **24** is operated. If it is determined that the seat air conditioner switch **24** is operated, the control continues to step **40**. On the other hand, if it is determined that the seat air conditioner switch **24** is not operated, the control continues to step **60**.

[**0031**] At step **40**, the target temperature TAO, which is calculated at step **20**, is corrected in accordance with a change degree of the seat air conditioner switch **24**. For example, if the air volume level of the seat blower **18** is increased during a cooling operation, the target temperature TAO is increased in accordance with the increase in the air volume level. If the air volume level of the seat blower **18** is increased during a heating operation, the target temperature TAO is reduced in accordance with the increase in the air volume level.

[**0032**] Next, at step **50**, a correlation between the target temperature TAO when the switch **24** is operated and the changed air volume of the seat blower **18** is learned. That is, values (constants) A through G of **FIG. 4** are learned.

[**0033**] Then, at step **60**, the air volume of the seat blower **18** is calculated with respect to the target temperature TAO

based on a characteristic diagram of the seat blower **18** shown in **FIG. 4**. The characteristic of the seat blower **18** is stored in the ROM (e.g. EEPROM) of the microcomputer.

[**0034**] Next, at step **70**, the air volume of the main blower **3** is determined based on the target temperature TAO. Then, at step **80**, the inside/outside air mode is determined based on the target temperature TAO. At step **90**, the air outlet mode is determined based on the target temperature TAO.

[**0035**] Next, at step **100**, a target opening degree Sd of the air mixing door **7** is calculated based on a following equation 2. The equation 2 is stored in the ROM.

$$Sd=\{(TAO-Te)/(Tw-Te)\}\times 100\ (\%)\text{(Ex.2)}$$

[**0036**] Next, at step **110**, a control condition (on/off) of the compressor is determined based on a target evaporator downstream temperature, which is a target temperature of the air cooled by the evaporator **5**. Next, at step **120**, control signals are sent to respective control devices such as servomotors and driving circuits so that the control target values determined at steps **60** through **110** are achieved. Next, at step **130**, the control is placed into a standby mode until a predetermined time period t elapses. After the predetermined time period t, the procedure from step **10** to step **130** is repeated.

[**0037**] Next, advantageous effects of the present invention will be described.

[**0038**] While the front air conditioning unit **1** and the seat air conditioning unit (e.g. seat blower **18**) are automatically controlled by the ECU **2**, if the seat air conditioner switch **24** is operated by the user, the setting of the switch **24** (e.g. air volume level of the seat blower **18**) is learned. Based on the learning, the characteristic diagram of the seat blower **18**, which is stored in the ROM, is changed. Therefore, from this time onward, under the same environmental condition, that is, under the same target temperature TAO, the air volume of the seat blower **18** is determined based on the changed blower characteristic diagram. Accordingly, the air-conditioning of the seat **17** is provided as desired by the user.

[**0039**] Further, when the air volume of the seat blower **18** is changed by the users switch operation, the target temperature TAO is corrected in accordance with the change degree of the air volume. Therefore, it is less likely that the air-conditioning of the passenger compartment will be affected by the change of the air volume of the seat blower **18**. Accordingly, it is possible to provide comfortable air-conditioned space.

Modifications

[**0040**] In the above embodiment, the seat air conditioner switch **24** includes the seat blower air volume switch that changes the volume level of the air to be blown from the seat **17**. Alternatively, as shown in **FIG. 5**, the seat air conditioner switch **24** can include a seat temperature switch **24***b* in addition to the seat blower air volume switch **24***a*, for example. A temperature of the air to be blown from the seat **17** is controlled by the seat temperature switch **24***b*. In this case, an air mixing door (not shown) for the seat air conditioner can be provided in the front air conditioning unit **1** in addition to the air mixing door **7** so that the temperature of the air to be blown from the seat **17** is changed by adjusting the opening degree of the seat air mixing door. Here, the air the temperature of which is controlled by the seat air mixing door is supplied to the seat air conditioning unit (seat blower **18**) through the duct (not shown).

[**0041**] Further, during the automatic control by the ECU **2**, if the seat temperature switch **24***b* is operated by the user, the target temperature TAO can be corrected by learning the changed temperature of the seat air conditioner. Therefore, from this time onward, under the same environmental condition, the seat air-conditioning operation is performed based on the corrected target temperature TAO. Accordingly, the comfort seat air-conditioning can be provided as desired by the user. Here, in the case that the seat air mixing door is provided, a seat target temperature TAO for the seat air-conditioning is calculated, separately from the target temperature TAO of the passenger compartment air-conditioning. When the seat temperature switch **24***b* is operated by the user, the seat target temperature TAO of the seat air-conditioning can be corrected.

[**0042**] Further, when the seat air conditioner switch **24** is operated by the user and the setting learned as described above, the learning result can be applied to an air-conditioning operation of another seat. That is, when the control condition of the seat air-conditioning of a first seat is changed by the manual switch operation, the changed control condition can be applied to air-conditioning operation of a second seat. Therefore, the control conditions of the plural seats can be changed together by operating the switch **24** of one of the seats.

[**0043**] The present invention should not be limited to the disclosed embodiments, but may be implemented in other ways without departing from the spirit of the invention.

What is claimed is:

1. An air conditioner for a vehicle comprising:

a seat air conditioner means for producing air blowing from a seat of the vehicle;

a storage means for storing a control characteristic of the seat air conditioner means;

a control means for automatically controlling the seat air conditioner means based on the control characteristic stored in the storage means; and

a manual setting means for setting a control condition of the seat air conditioner means,

wherein when the manual setting means is operated during an automatic control of the seat air conditioner means, a setting condition of the manual setting means is learned and the control characteristic is changed based on the learning.

2. The air conditioner according to claim 1, further comprising:

a compartment air conditioner means for air-conditioning a passenger compartment of the vehicle;

a target temperature calculating means for calculating a target temperature of air to be blown into the passenger compartment with respect to a setting temperature of the passenger compartment, wherein the control means automatically controls the compartment air conditioner means based on the target temperature; and,

a target temperature correcting means for correcting the target temperature in accordance with a change of the

control condition of the seat air conditioner means when the control condition of the seat air conditioner means is changed by operation of the manual setting means.

3. The air conditioner according to claim 1, wherein the manual setting means is provided such that at least one of a temperature and a volume of air to be blown from the seat is changed.

4. The air conditioner according to claim 1, further comprising:

a first seat and a second seat respectively air-conditioned by the seat air conditioner means,

wherein when an air-conditioning control of the first seat is changed by operating the manual setting means, the learning is applied to an air-conditioning control of the second seat.

5. The air conditioner according to claim 2,

wherein the compartment air conditioner means includes a front air conditioner unit having a main blower, a temperature control device, and an air outlet through which air is blown into the passenger compartment.

6. The air conditioner according to claim 5, further comprising:

a seat air volume calculating means for calculating a volume of air to be blown from the seat with respect to the target temperature based on the control characteristic stored in the storage means;

a main blower level determining means for determining a volume of air to be blown by the main blower based on the target temperature;

an air outlet mode determining means for determining a mode of the air outlet of the front air conditioning unit based on the target temperature; and

a device controlling means for controlling the temperature control device based on the target temperature.

7. The air conditioner according to claim 2,

wherein the seat air conditioner means includes a seat blower,

wherein the target temperature correcting means includes a function of increasing the target temperature in accordance with an increase in an air volume of the seat blower by operation of the manual setting means during a cooling operation.

8. The air conditioner according to claim 2,

wherein the seat air conditioner means includes a seat blower,

wherein the target temperature correcting means includes a function of reducing the target temperature in accordance with an increase in an air volume of the seat blower by operation of the manual setting means during a heating operation.

9. The air conditioner according to claim 2,

wherein the seat air conditioner means includes a seat blower,

wherein the control characteristic of the seat air conditioner means is provided by a relationship between the target temperature and the air volume of the seat blower,

wherein the target temperature correcting means includes a function of correcting constants of the control characteristic for learning a correlation between the target temperature when the setting means is operated and the changed air volume of the seat blower.

10. A method of controlling a vehicle air conditioner having a front air conditioner unit for air-conditioning a passenger compartment of a vehicle and a seat air conditioner unit for air-conditioning a seat of the vehicle by a seat blower, the method comprising:

calculating a target temperature of air to be blown into the passenger compartment with respect to a setting temperature of the passenger compartment while the front air conditioner unit is automatically controlled by a control means;

determining whether a switch of the seat blower for changing an air blow level is operated;

correcting the target temperature in accordance with a change of the switch when it is determined that the switch is operated;

calculating a volume of air to be blown by the seat blower based on a seat blower characteristic stored in a storage means with respect to the target temperature; and

determining a volume of air to be blown by a main blower of the front air conditioner unit based on the target temperature.

11. The method according to claim 10, further comprising:

determining air outlet modes of the front air conditioner unit; and

controlling a temperature controlling device of the front air conditioner unit based on the target temperature.

12. The method according to claim 10, wherein when the air volume of the seat blower is increased by operation of the switch during a cooing operation, the correcting step increases the target temperature in accordance with an increase in the air volume.

13. The method according to claim 10, wherein when the air volume of the seat blower is increased by operation of the switch during a heating operation, the correcting step reduces the target temperature in accordance with an increase in the air volume.

14. The method according to claim 10, wherein the correcting step corrects constants of the blower characteristic for learning a correlation between the target temperature at a time that the switch of the seat blower is operated and the changed air volume of the seat blower.

* * * * *